Epidemiological Studies Criticized by Seltzer. The appraisal of the Royal College of Physician's Report by Seltzer (Lancet 1: 243-248, 1972) applies to the 1971 document. This was in turn followed by:

1. A letter from Fletcher (Lancet 12 February, 1972).
2. A letter from Sterling (Lancet 29 April, 1972).
3. A letter from Seltzer (Lancet 11 March, 1972).
4. A letter from Burch (Lancet 10 June, 1972).
5. A letter from Fletcher (Lancet 1 July, 1972), and finally
6. A letter from Doll (Lancet 15 July, 1972).

Occasional Survey

A CRITICAL APPRAISAL OF THE ROYAL COLLEGE OF PHYSICIANS' REPORT ON SMOKING AND HEALTH

CARL C. SELTZER

Department of Nutrition, Harvard School of Public Health, Boston, Massachusetts 02115, U.S.A.

Summary The claims in the Royal College of Physicians' report *Smoking and Health Now* are examined with reference to certain secular changes in mortality for British doctors as compared with those for the general population. The data as presented are found to exhibit geographical and populational restrictions, age restrictions, and unexpected changes in classification of diseases; they also omit a crucial time period and assume certain unverified trends in smoking habits. The statements and claims of the Royal College of Physicians are not supported by the re-examination of certain data included in the report, and by an analysis of pertinent data that were omitted. The appraisal of the full data illustrates the hazards of drawing firm conclusions from secular changes in death-rates, and raises doubts that the Royal College of Physicians' report contains the "strongest evidence there is of the value of giving up cigarettes".

INTRODUCTION

IN 1971 the Royal College of Physicians (R.C.P.) issued a report entitled *Smoking and Health Now*.[1] A table in that report contained secular comparisons for the death-rates during 1953–57 and 1962–65 of two groups of men at ages 35–64. One group was taken from R. Doll and A. B. Hill's sample of British doctors; the other group was assembled from the Registrar General's data for England and Wales. According to the R.C.P. report, the contrasted data constitute "the strongest evidence there is of the value of giving up cigarettes".

The interpretation of secular changes in mortality is a difficult statistical procedure. As Bradford Hill has stated, "In making comparisons between death-rates from different causes at different times . . . it must be realised that one is dealing with material which is, in Raymond Pearl's words, 'fundamentally of a dubious character'".[2] Secular changes in these rates may be affected by vagaries of death-certificate reporting, such as accuracy of diagnosis, faulty certifications of death, and trends in reporting; and also by influences related to sex, race, socioeconomic status, geography, and occupation. The uncertain effects of these features are difficult to exclude when a specific exogenous factor is held responsible for the observed secular changes.

Because the comparison of secular death-rates is often an important technique in epidemiological analysis, and because the results of such a comparison have been made a central issue in the R.C.P. report, the validity of the statistical procedures has been appraised here.

CLAIMS OF THE R.C.P.

The R.C.P. drew its conclusions mainly from data in table 2.3 of its report (reproduced here in table 1), and stated that:

(1) The death-rate of British doctors declined more than that of the general population in the interval between the time periods 1953–57 and 1962–65.

(2) In the category "major diseases related to cigarette smoking", the death-rates declined in British doctors but increased in the general population.

(3) In the category "all unrelated causes", the death-rates declined equally in British doctors and in the general population.

From data elsewhere in the report, the R.C.P. also stated that British doctors' cigarette smoking declined by about 50% between 1951 and 1965, but "there was little corresponding change in the smoking habits of the general population during the same period".

The associated secular changes in death-rates and

TABLE I—CHANGES IN DEATH-RATES PER 100,000, STANDARDISED FOR AGE IN DOCTORS AND IN ALL MEN AGED 35–64 IN ENGLAND AND WALES 1953–1957 AND 1962–1965 (REPRODUCED FROM R.C.P. TABLE 2.3)

Cause of death	Male doctors			All men in England and Wales		
	Period		% Change	Period		% Change
	1953–57	1962–65		1953–57	1962–65	
Coronary heart-disease	294	277	−6	219	290	+32
Other cardiovascular diseases	167	157	−6	185	152	−18
All cardiovascular diseases	461	434	−6	404	442	+ 9
Cancer of the lung	60	37	−38	113	120	+ 6
Chronic bronchitis	18	14	−22	74	71	− 4
Major diseases related to cigarette smoking	539	485	−10	591	633	+ 7
Other cancers*	130	99	−24	152	145	− 5
Other causes*	184	163	−11	250	188	−25
All unrelated causes	314	262	−17	402	332	−17
All causes	853	747	−12	993	966	− 3

* These include a small number of deaths from cancers of mouth, throat, and œsophagus, from tuberculosis, from cirrhosis of the liver, and from peptic ulcer, which are related to cigarette smoking but make only a small contribution to the excess deaths of cigarette smokers.

in smoking were interpreted by the R.C.P. as follows. As cigarette smoking declined more for British doctors than for the general population, the death-rate between the two time-periods declined more for the doctors than for the general population. Furthermore, although the British doctors and the general population had similar changes in death-rates for diseases "unrelated" to cigarette smoking, the death-rates for the "major diseases related to cigarette smoking" declined for the doctors but rose for the general population. From these associations the R.C.P. concluded that "the benefit that British doctors have won at the peak of their professional careers provides the strongest evidence there is of the value of giving up cigarettes".

UNCERTAINTIES IN R.C.P. DATA

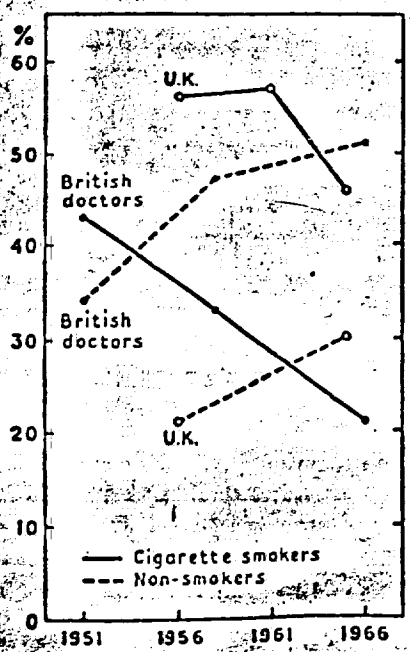
An examination of table I and the R.C.P. statements reveals several uncertainties and inconsistencies.

Data about Cigarette Smoking

According to the R.C.P. report, cigarette smoking between 1951 and 1965 declined among British doctors by about half (from 43% to 21%), and the proportion of non-smokers (including ex-smokers) rose from 34% to 51%. During this period, there was "a striking contrast between the smoking habits of doctors and those of other men [in the general population] over the age of 35 . . . [since] there was little corresponding change in the smoking habits of the general population during the same period".

The R.C.P. states that it obtained its data about the smoking habits of British doctors from the Doll and Hill 1964 study [3] and from Doll and M. C. Pike by personal communication. The R.C.P. source of its comments on the smoking habits of the men from the general population is clear for 1965 but not for the immediately prior periods. The figures for the smoking habits of United Kingdom men in 1965 were those published by the Tobacco Research Council (T.R.C.).[4]

The figure indicates the changes in the smoking habits of British doctors and United Kingdom men of the same ages between 1951 and 1966. For the sake of clarity, forms of smoking other than non-smoking and cigarette smoking have been omitted. (Following the procedures of the R.C.P., non-smokers consist of never-smokers and ex-smokers, while cigarette smokers refer to cigarette smokers only.) The data with regard to British doctors are those presented by the R.C.P. (in its fig. 1.4); the U.K. data for 1965 are those derived by the R.C.P. from T.R.C. data [4]; U.K. figures for 1961 have been derived by me from the same source,[4] and those for 1956 have been obtained from an earlier research paper of the Tobacco Research Council.[5] Earlier U.K. data (in the same form) for 1951–55 are not available from the Tobacco Research Council survey.



Changes in smoking habits of British doctors and men in U.K. aged 35 and over.

According to T.R.C. data, between 1951 and 1956 cigarette consumption per adult male in the U.K. increased by only 4%. This figure refers to cigarette consumption, not proportion of cigarette smokers; nevertheless, it seems reasonable to conclude that the proportion of cigarette smokers among U.K. men did not change strikingly between 1951 and 1956. After 1956, however, the proportion of non-smokers in the U.K. over the age of 35 increased by 15% (see figure), and the corresponding rise for British doctors was 19%. Cigarette smokers constituted 56% of the U.K. men in 1956 and 57% in 1961, but only 46% in 1965, a change of 19%. From 1961 to 1965, cigarette smoking among British doctors dropped by 19%. These findings receive further confirmation from R.C.P. fig. 1.1, which shows a drop in cigarette consumption among men in the U.K. population since 1960.

These data thus support the R.C.P.'s contention that the proportion of cigarette-smoking British doctors fell between 1951 and 1965, but they do not support the statement about "little corresponding change" in the general population. From 1956 to 1965, the non-smokers in the general population increased at a rate similar to that shown by British doctors. From 1961 to 1965 the percentage of cigarette smokers decreased at about the same rate in both the general population and the doctors.

Changes in Classification of Disease

Another interesting feature of the R.C.P. table is the classification of disease, which was done by the R.C.P. in a manner different from that of Doll and Hill. In Doll and Hill's published studies of British doctors in 1964 and 1966,[3,6] the diseases regarded as "related" to cigarette smoking were cancer of the lung and upper respiratory and digestive tracts, chronic bronchitis, coronary heart-disease, peptic ulcer, cirrhosis of the liver, and pulmonary tuberculosis. Under "unrelated causes", Doll and Hill included other cancers, other respiratory disease, cerebrovascular disease, other cardiovascular disease, violence, and other causes.

In the R.C.P. tabulation, many of Doll and Hill's "unrelated diseases" were transferred to the category of "related" diseases; thus among "major diseases related to cigarette smoking" are rheumatic fever, rheumatic pericarditis, endocarditis, and myocarditis, diseases of the mitral, aortic, and tricuspid valves, acute and subacute bacterial endocarditis, gangrene, varicose veins, and hæmorrhoids. These and other diseases listed by the R.C.P. under "other cardiovascular diseases" comprise numbers 400–468 (all diseases of the circulatory system, less 420) and 330–334 (vascular lesions affecting the central nervous system) of the International Statistical Classification of Diseases, Injuries and Causes of Death.[7]

No explanation is provided for these changes in the Doll/Hill classification, although the R.C.P. report relied so heavily on other aspects of the Doll/Hill data. Explanations were, however, provided for certain changes from "related" diseases to "unrelated" diseases.

Geographic Restrictions

The R.C.P. compared death-rates for British doctors and for all men in England and Wales. The Doll/Hill sample of British doctors,[3] however, was drawn from the U.K. (Scotland and Northern Ireland, as well as England and Wales). The contrasted populations are thus geographically different: a more suitable comparison for the British doctors would be with all men in the United Kingdom, since the male death-rates of the U.K. may differ from those of only England and Wales.

Population Restrictions

Doctors are not typical of all men in England and Wales. They differ in race, social and economic status, "life style", education, and other characteristics that are themselves related to rates of disease and mortality, and that may affect trends in death-rates for the contrasted populations.

Age Restrictions

The R.C.P. data are restricted to men ages 35 to 64, although the data for all adult ages would ordinarily extend from ages 35 to 84. Since the R.C.P. statements are not confined to conclusions about the health of cigarette smokers only at ages 35–64, the absence of data for all adult ages would be a significant limitation on the R.C.P. conclusions.

Intermediate Time Period

The R.C.P. compared death-rates for the periods 1953–57 and 1962–65, omitting 1958–61. When two separated periods in time are compared without regard to the intervening period, any conclusions about a trend are tenuous, because the intermediate data may alter any trend found between the two extremes of time.

AUGMENTATION OF R.C.P. DATA

Apart from the uncertainties in the sampling of doctors, the unexplained changes in classification of disease, and the inaccurate description of smoking habits for the general population, the R.C.P. report did not consider the omissions just cited in geography, age, and time periods. Since the missing data might help clarify some of the issues, a reanalysis of the R.C.P. contentions seemed desirable, with the data expanded to include geographic, age, and temporal information that had been omitted in the R.C.P. report. The additional details for these features of the general population of the U.K. were obtained from the Registrar General's reports.[8] The corresponding details about the British doctors were obtained from the latest Doll and Pike report.[9]

TABLE III—% CHANGES IN AGE-STANDARDISED DEATH-RATES PER 100,000 FOR BRITISH DOCTORS AND ALL MEN IN ENGLAND AND WALES AGED 35–64*

Cause of death	British doctors		All men in England and Wales	
	From 1953–57 to 1958–61	From 1958–61 to 1962–65	From 1953–57 to 1958–61	From 1958–61 to 1962–65
Coronary heart-disease	− 7	+ 1	+15	+15
Other cardiovascular diseases	+18	−20	−10	− 9
All cardiovascular diseases	+ 2	− 8	+ 4	+ 5
Cancer of the lung	− 7	−34	+ 5	+ 1
Chronic bronchitis	−33	+17	− 1	− 3
Major diseases related to cigarette smoking	0	−10	+ 3	+ 4
Other cancers	− 6	−20	− 2	− 3
Other causes	+ 5	−16	−16	−11
All unrelated causes	+ 1	−17	−10	− 8
All causes	0	−13	− 2	− 1

* % changes are used in this form to conform with R.C.P. practice.

Missing Time Period

For the same ages and geography used in the R.C.P. report, the data of the missing time interval are shown here in table II. This table indicates the annual age-standardised rates per 100,000 men aged 35–64, for British doctors and all men in England and Wales during the three successive periods 1953–57, 1958–61, and 1962–65. In table III the "absolute" values shown in table II are converted into percentage changes in death-rates during the three time periods. The figures in tables II and III show the following results that are pertinent to the R.C.P. statement.

The claim that total death-rates of doctors declined more than those of the general population.—As shown

TABLE II—AGE-STANDARDISED ANNUAL DEATH-RATES PER 100,000 MEN, AGES 35 TO 64*
(ADAPTED TO DISEASE CLASSIFICATIONS OF R.C.P. TABLE 2.3)

Cause of death	British doctors			All men in England and Wales		
	1953–57	1958–61	1962–65	1953–57	1958–61	1962–65
Coronary heart-disease	294	273	277	219	252	290
Other cardiovascular diseases	167	197	157	185	167	152
All cardiovascular diseases	461	470	434	404	419	442
Cancer of the lung	60	56	37	113	119	120
Chronic bronchitis	18	12	14	74	73	71
Major diseases related to cigarette smoking	539	538	485	591	611	633
Other cancers	130	123	99	152	149	145
Other causes	184	193	163	250	211	188
All unrelated causes	314	316	262	402	360	332
All causes	853	854	747	993	971	966

* The data for the first and last time periods are taken from the R.C.P. report. The data for the middle time periods were derived from the Doll and Pike report.[9] For British doctors, the years run from Nov. 1 to Oct. 31. To maintain consistency with R.C.P. table 2.3, we have followed the R.C.P. labelling of the period years.

in table III, the reduction in cigarette smoking among British doctors between 1953–57 and 1958–61 was not accompanied by any change in overall death-rate. During the same interval the death-rate for all men in England and Wales fell by 2%. Between 1958–61 and 1962–65, the total death-rates of British doctors fell more than those of the general population, although cigarette smoking from 1951 to 1965 declined at least as fast in terms of percentage among the general population than in British doctors. From 1958–61 to 1962–65, the reduction in total death-rates was 1% in the general population and 13% in the British doctors. Thus, when the three time periods are considered successively, the total death-rates of British doctors are not found to have declined consistently more than the general population.

The claim that death-rates for "all unrelated causes" declined equally in British doctors and in the general population.—This assertion is not supported by the data in tables II and III. From 1953–57 to 1958–61, the death-rates for "unrelated causes" among British doctors rose by 1% while those of the general population fell by 10%. From 1958–61 to 1962–65, the death-rates for these "unrelated causes" decreased by 17% in British doctors and by 8% in the general population.

The claim that death-rates for "major diseases related to cigarette smoking" declined in the British doctors but increased in the general population.—From 1953–57 to 1958–61, there was no drop in the death-rates of British doctors for "major diseases related to cigarette smoking". The rates were essentially the same: 539 and 538 per 100,000 men, respectively. For the same category of diseases over the same interval, the death-rates increased by 3% in all men in England and Wales. In the second interval, however, the R.C.P. claim is confirmed. The death-rates declined (−10%) in British doctors and rose (+4%) in the general population. The general population's increase in death-rates between 1958–61 and 1962–65 occurred, however, despite the concomitant reduction in cigarette smokers of this population between 1961 and 1965.

Inconsistencies in patterns of specific diseases.—Tables II and III contain several inconsistencies in the patterns of specific diseases—especially in the data of British doctors for changes in death-rates between the first interval (1953–57 to 1958–61) and the second interval (1958–61 to 1962–65). For example, in British doctors, the death-rate for coronary heart-disease declined in the first interval and rose in the second interval; the death-rates for "other cardiovascular diseases" and for "all cardiovascular diseases" rose substantially in the first interval and then fell substantially in the second. The rate for chronic bronchitis fell by 33% and then rose by 17%. For the categories of "all causes", "major diseases related to cigarette smoking", and "unrelated causes", the British doctors had almost no changes in the death-rates in the first interval, followed by notable decreases in the second interval. These inconsistencies occurred despite the almost constant rate of decline of cigarette smoking among British doctors from 1951 to 1966. For the general population of England and Wales, on the other hand, the trends of death-rates were strikingly consistent for the specific disease categories in both the first and second intervals despite the inconstant cigarette smoking patterns in this population. As previously noted, the proportion of cigarette smokers in the general population changed little between 1956 and 1961, but then dropped sharply from 1961 to 1965.

Missing geography.—The death-rates for all men in the United Kingdom ages 35–64 (in contrast to all men in England and Wales) have been derived for the missing period 1958–61 from the Registrar General's reports (table IV). These data permit a comparison of the death-rate changes for the two intervals (from 1953–57 to 1958–61 and from 1958–61 to 1962–65) in the men of the United Kingdom—a more suitable comparison for the sample of British doctors. In the data for U.K. men, the death-rates for all causes fell in the first interval (while smoking habits were essentially unchanged), and stayed virtually the same in the second interval (while smoking decreased). The death-rates for "related" diseases rose in the first period and continued to rise in the second. For "unrelated" diseases, the death-rate of U.K. men fell more in the first interval (−12%) than in the second (−8%). Thus, when the missing time period and missing geography are taken into consideration for ages 35–64, the claims of the R.C.P. are not substantiated. The discrepancies are most notable for the events of the first interval.

TABLE IV—AGE-STANDARDISED DEATH-RATES PER 100,000 IN BRITISH DOCTORS AND IN MEN OF UNITED KINGDOM

Deaths from	British doctors			United Kingdom		
	1953–57	1958–61	1962–65	1953–57	1958–61	1962–65
Ages 35–64:						
Related causes	539	538	455	586	614	639
Unrelated causes	314	316	262	425	375	346
All causes	853	854	747	1011	989	985
Ages 35–84:						
Related causes	1180	1231	1202	1401	1435	1473
Unrelated causes	560	570	528	817	762	719
All causes	1740	1801	1730	2218	2197	2192

Missing Ages

In this section, the data are expanded to include the missing ages (35–84) as well as the missing time period (1958–61).

Table V shows the death-rates of the British doctors and all men in England and Wales, ages 35–84, for the three successive time periods 1953–57, 1958–61, and 1962–65. The percentage changes over the two time intervals are presented in table VI. The figures in these tables show the following results that are pertinent to the R.C.P. statements.

Claim that total death-rates of doctors decline more than those of the general population.—In the age-groups 35–84, for the time periods considered by the R.C.P., the death-rates of British doctors did not consistently decline more than those of the general population. Between the two external time periods (1953–57 and 1962–65) the total death-rate of British doctors fell

TABLE V—AGE-STANDARDISED ANNUAL DEATH-RATES PER 100,000 MEN, AGES 35–84*
(ADAPTED TO DISEASE CLASSIFICATIONS OF R.C.P. TABLE 2.3)

Cause of death	British doctors			All men in England and Wales		
	1953–57	1958–61	1962–65	1953–57	1958–61	1962–65
Coronary heart-disease	519	564	559	425	491	564
Other cardiovascular diseases	507	533	506	682	603	541
All cardiovascular diseases	1026	1097	1065	1107	1094	1105
Cancer of the lung	110	85	83	149	171	188
Chronic bronchitis	44	49	54	160	170	184
Major diseases related to cigarette smoking	1180	1231	1202	1416	1435	1477
Other cancers	253	236	224	307	301	294
Other causes	307	334	304	482	438	406
All unrelated causes	560	570	528	789	739	700
All causes	1740	1801	1730	2205	2174	2177

* British doctors' data derived from Doll and Pike.[4] For British doctors, the years run from Nov. 1 to Oct. 31. For reasons of consistency with R.C.P. table 2.3, we have followed the R.C.P. labelling of the period years.

by only 0·6% (1740 to 1730), as compared to a decline of 1·3% (2205 to 2177) in all men in England and Wales. When the additional age range and missing time periods are inspected, the death-rate for the British doctors is seen to have increased by 4% from 1953–57 to 1958–61, despite the concomitant decrease in cigarette smoking. Over the same interval the death-rates for the general population declined by 1%. From 1958–61 to 1962–65, British doctors' overall death-rate declined more than that of the general population, which showed essentially no change, despite the drop in cigarette smoking.

Claim that the death-rates for the category of "all unrelated causes" declined equally in British doctors and in the general population.—This claim is not supported by the data for ages 35–84. Between the external periods 1953–57 and 1962–65, the reduction in death-rates for "unrelated causes" in the general population (11%) was almost twice as great as the comparable decline in the British doctors (6%). When the data are examined for the effects of the missing time period, the R.C.P. contention is about right for the second time interval, but not for the first. In the first interval the death-rate for "unrelated causes" increased by 2% in the British doctors, in contrast to that of the general population, which showed a 6% drop.

Claim that the death-rates of "major diseases related to cigarette smoking" declined in British doctors but increased in the general population.—Again, this assertion is not fully supported by the data for ages 35–84. From the "outside" time periods, 1953–57 to 1962–65, the death-rates for "related" diseases increased in both populations, rising by 2% in British doctors and by 4% in all men in England and Wales. For the first "inside" interval, from 1953–57 to 1958–61, the data of ages 35–84 also do not support this R.C.P. contention. The death-rates for the classification "major diseases related to cigarette smoking" increased in both British doctors (4%) and in the general population (1%). In the second interval doctors' death-rates declined (2%) and the general population rates increased (3%). Thus, the apparent contradiction of a rising death-rate during a fall in smoking occurred in British doctors for the first interval and in the general population for the second.

TABLE VI—% CHANGES IN AGE-STANDARDISED DEATH-RATES PER 100,000 FOR BRITISH DOCTORS AND ALL MEN IN ENGLAND AND WALES AGED 35–84.

Cause of death	British doctors		All men in England and Wales	
	From 1953–57 to 1958–61	From 1958–61 to 1962–65	From 1953–57 to 1958–61	From 1958–61 to 1962–65
Major diseases related to cigarette smoking	+4	−2	+1	+3
All unrelated causes	+2	−7	−6	−6
All causes	+4	−2	−1	0

Inconsistencies in patterns of specific diseases.—An additional inconsistency in the R.C.P. data is noted for coronary heart-disease. For ages 35–84, the death-rates from 1953–57 to 1962–65 in British doctors increased by 8% during a period of declining cigarette smoking. In addition, although the category of "other cardiovascular diseases" showed no change in British doctors aged 35–84 between the same two periods, the death-rates for the same diseases declined by 21% in all men in the general population of England and Wales. The death-rates for "all cardiovascular disease" increased by 4% in British doctors aged 35–84, in contrast to essentially no change for all men in England and Wales. Other inconsistencies occur in the patterns of specific diseases in the expanded age-and-time data. In British doctors, the death-rates for coronary heart-disease, for "other cardiovascular diseases", and "all cardiovascular disease" increased in the first interval and decreased in the second. Despite a constant decline in doctors' cigarette smoking, cancer of the lung decreased by 23% over the first interval and by only 2% in the second interval.

With respect to all men in England and Wales, the trends in death-rates for the specific diseases are quite consistent in both the first and second intervals, despite the inconstant changes in smoking habits in the general population.

Missing geography.—The bottom part of table IV summarises the expanded geographical data for the augmented age and time intervals. The lower half of this table shows the age-standardised death-rates per 100,000 men ages 35–84 for British doctors and for all men in the United Kingdom during the successive periods 1953–57, 1958–61, and 1962–65. The data show differences in the death-rates for the men in the United Kingdom as compared to corresponding results for the men in England and Wales shown in table V. The basic trend in the changes from one time period to the next for the United Kingdom men are not appreciably different from those found in the corresponding figures for England and Wales. Consequently, it seems reasonable to conclude that the omissions in age and time period, rather than geography, are responsible for any distortions or discrepancies in the claims of the R.C.P.

DISCUSSION

The statements and claims of the Royal College of Physicians, based on table 2.3 of the R.C.P. report, are not supported by a re-examination of certain data in the report and by analysis of data that were omitted.

One basic argument of the R.C.P. rests on the assertion that cigarette smoking fell in British doctors without a comparable decline in smoking in the general population. This assertion does not seem true for the period 1961 to 1965, when the per cent decrease of cigarette smokers was about the same in the general population as in the Doll/Hill sample of British doctors.

In addition, the omission of data for the age group 35–84 and for the middle time period (1958–61) has created an erroneous parallelism of falling death-rates and declining cigarette smoking in British doctors. When considered for ages 35–84 rather than 35–64, the death-rates of British doctors did not consistently decline, and for most diseases actually rose rather than fell for the two time periods considered by the R.C.P. When these two time periods are augmented by their middle period (1958–61) the doctors' death-rates showed many inconsistencies.

It might be argued that the benefits derived from stopping cigarette smoking take time to appear, and that the interval from 1953–57 to 1958–61 is too short to show any appreciable reduction in death-rates for certain causes of disease. However, table 25 in Doll and Hill's 1964 report on the British doctors [3] shows that in less than five years after smoking was stopped, the death-rate of former cigarette smokers had fallen by 25% from the level of continuing cigarette smokers (from 7·19 to 5·36 per 1000) for "related diseases" and by 34% for the "unrelated diseases" (from 9·43 to 6·26 per 1000). In interpreting these data, Doll and Hill concluded that "the fall in mortality with the stopping of smoking is a real effect as far as the 'related' diseases are concerned, while for the 'unrelated' diseases it is an artifact due to selection".

Regardless of the reasons for the decline, the mortality-rates of former cigarette smokers seem to decline "immediately" after smoking is given up. Such a decline, however, was not reflected in the mortality-rates for British doctors from the period 1953–57 to 1958–61. On the contrary, from 1953–57 to 1958–61, when the proportion of cigarette smokers dropped sharply, the death-rates of British doctors (ages 35 to 84) showed an increase of 4%, 2%, and 4%, respectively, for "related causes", "unrelated causes", and "all causes", and for ages 35–64 changes of 0%, +1%, and 0%.

A curious feature of Doll and Hill's 1964 report on British doctors is that the death-rates of former cigarette smokers (less than 5 years after stopping smoking) fell more for "unrelated causes" than for "related causes". This inconsistency is also found in R.C.P. table 2.3, where for British doctors the death-rates for "unrelated causes" fell by 17%, compared to a 10% fall for "major diseases related to cigarette smoking".

The absence of data for all adult ages in the R.C.P. report is significant but seems less serious than the omission of the data for the middle time period, 1958–61. Since a consideration of the middle-period data seems to alter the results so distinctly, the omission of this information is unfortunate.

This reappraisal of the full data provides strong support for Bradford Hill's injunction about the hazards of analysing secular changes in death rates. The reappraisal also raises major doubts about the Royal College of Physicians' conclusion that it has presented "the strongest evidence there is of the value of giving up cigarettes".

This study was supported in part by the Fund for Research and Teaching of the Department of Nutrition, Harvard School of Public Health.

REFERENCES

1. Smoking and Health Now: a report of the Royal College of Physicians. London, 1971.
2. Hill, A. B. Principles of Medical Statistics; p. 201. London, 1956.
3. Doll, R., Hill, A. B. *Br. med. J.* 1964, i, 1399, 1460.
4. Todd, G. F. (editor). Statistics of Smoking in the United Kingdom: Tobacco Research Council research paper no. 1. London, 1969.
5. Todd, G. F. (editor). Statistics of Smoking in the United Kingdom: Tobacco Research Council research paper no. 1. London, 1957.
6. Doll, R., Hill, A. B. *Natn. Cancer Inst. Monogr.* 1966, no. 19, p. 205.
7. Registrar General's statistical reviews of England and Wales for the years 1953 and 1958. H.M. Stationery Office.
8. Registrar General's Statistical Review of England and Wales for the years 1953–62; Annual Report of the Registrar General for Scotland, 1953–62; Annual Report of the Registrar General for Northern Ireland, 1953–62.
9. Doll, R., Pike, M. C. *Jl R. Coll. Physns, Lond.* 1972, 6, 216.

SMOKING AND HEALTH

SIR,—Dr. Seltzer's article (Jan. 29, p. 243) on the Royal College of Physicians' report on smoking and health is in fact concerned only with one table in the report and the conclusions derived from it that stopping smoking increases life expectation. With this he disagrees. The inadequacy of Dr. Seltzer's arguments are so well presented by your leading article and by Sir Richard Doll (Feb. 5, p. 322) that no more need be said about them, but one error should be corrected. He says that no reason was given for the classification of diseases related and unrelated to cigarette-smoking which was used in the table. If he had read the rest of the report he would have found the explanation in paragraph 6.11. There he would also have found a reference to independent evidence of a favourable trend in coronary deaths among doctors associated with their decline in cigarette-smoking, which he does not consider in his article.

C. M. FLETCHER,
Secretary,
Royal College of Physicians' Committee on Smoking and Health.

Department of Medicine,
Royal Postgraduate Medical School,
Hammersmith Hospital,
London W.12.

REPORT ON SMOKING AND HEALTH

SIR,—In your issue of Jan. 29 (p. 243) you published a paper by Dr. Carl C. Seltzer in which he examined some of the data on which the Royal College of Physicians based its conclusions concerning cigarette smoking and health. In an accompanying editorial (p. 238) you expressed considerable criticism of Dr. Seltzer's critique.

The editorial disputed Dr. Seltzer on one main point. The Royal College of Physicians had attached particular importance to the observation that between 1953 and 1965 the mortality in male British doctors, many of whom it was believed had stopped smoking, decreased more rapidly than in all men of the same age in England and Wales, among whom it was believed that smoking habits had remained relatively unchanged. Seltzer objected to the geographical, population, and age restrictions and unexpected changes in classification of disease in the data used by the Royal College, to the omission of crucial time periods, and to the assumption of unverified trends in smoking habits. Seltzer found that, once all the data were included which he considered to be pertinent, differences in mortality trends between former smokers and non-smokers largely disappeared.

Dr. Seltzer's findings also were attacked by Sir Richard Doll (Feb. 5, p. 322), who pointed out that pattern of change in mortality with the length of time that smoking had been stopped varied with the nature of the disease, but that ". . . after smoking had been stopped for ten or more years the mortality from 'related causes' had fallen by 38% . . .".

Now I find it extremely curious that Seltzer's conclusions, disputed in that editorial, had been quietly conceded by others, foremost of whom is Doll. In an analysis of lung-cancer death-rates presented to the Royal Statistical Society—an analysis of the same data on which the R.C.P. has based its report—Doll says: "The impression has, therefore, been gained that the incidence of the disease falls when smoking is stopped. In fact, this is not necessarily so; and the published results are compatible with the decreasing incidence, the constant incidence, or one which rises steadily but less rapidly than in men who continue to smoke." And, on the same page: "The results are compatible with the hypothesis that damage produced by smoking is irreversible and that the risk remains practically the same as it was when smoking was stopped; the trend, however, is smooth and suggests that the risk may fall slightly at first and rise again slowly in keeping with the increase in risk in non-smokers."[4] Here Doll maintained for lung cancer precisely what Seltzer did for all mortality—namely, that when all pertinent time periods are considered, the change in mortality between non-smokers and those who cease smoking differs in no way. Doll used this assertion to support his claims that the damage done by smoking is irreversible. The Royal College (and Doll on other occasions) have given a different slant to the same data.

Your editorial criticised Seltzer also for disputing the belief that since 1960 smoking declined among British doctors but not in the general population. Here, again, we find that Doll, too, reported the disputed decline in cigarette consumption among men in the United Kingdom.[5] According to substantive evidence available for some time then, it would appear that Dr. Seltzer's critique was justified.

The issue of smoking and health calls forth emotional responses of which we all need to beware, since they tend to distort the scientific process. One example of what may happen is the way all parties have ignored the tenuous base of their numbers game. Doll's data on British physicians are based on a self-selected sample of physicians who voluntarily responded to questionaries. 30% of the physicians failed to respond to the original inquiry,[6] and the proportion of respondents has continuously decreased since then with each follow-up attempt. The danger of drawing conclusions from samples with high non-response rates has been generally recognised. Bradford Hill calls a non-response rate of 2 to 3% "satisfactorily small".[7] And, indeed, the characteristics of responding physicians are reported to be quite different from those of the general population.[8] As a result, any differences between observations on volunteering physicians and on census populations are difficult to interpret. In addition, estimates of smoking rates are uncertain in the extreme. Estimates of the smoking habits of the same population by use of similar methods may differ by more than a third for some age-groups.[9] From data with all these shortcomings, not much can be learned.

Department of Applied Mathematics
and Computer Science,
School of Engineering and Applied Science,
Washington University,
St. Louis, Missouri 63130. THEODOR D. STERLING.

SMOKING AND HEALTH

SIR,—Your editorial accompanying my article of Jan. 29 (p. 243) offered some apparent justification for the omission of data in the Royal College of Physicians' (R.C.P.) report on smoking and health [1] and raised a question about my own sources of data. I should like to comment on the points raised.

(1) The R.C.P. analysed data for ages 35–64. The analysis did not include data for ages 65–84 or the total results for ages 35–84. You imply that the missing data were not important, because of an allegedly lesser smoking effect in older age-groups. Nevertheless, your conclusions (and those in the R.C.P. report) referred to general effects of stopping smoking; not to any one age-group. Since the trends cited by the R.C.P. for ages 35–64 become reversed or distinctly muted when the data are examined for ages 35–84, this additional information warranted inclusion in the report. The extrapolation of the conclusion to all age-groups certainly seems inappropriate.

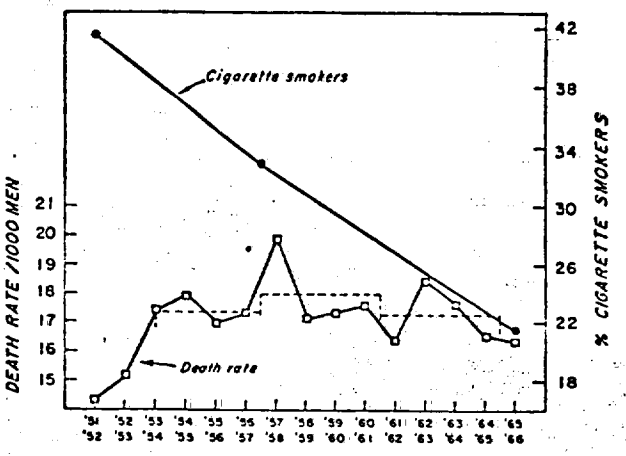
(2) The trends reported by R.C.P. were obtained by a comparison of data for 1953–57 and 1962–65. A straight line can always be drawn between two points, but the validity of the trend is enhanced if at least three points fit the line. The R.C.P. report did not include data for such a third point—the intermediate time period 1958–61. When data for the missing "middle point" are included many of the apparent trends vanish or are substantially altered. You justify the omission of this important middle time period by stating that the main effects of stopping smoking, although observed "surprisingly quickly", are seen more clearly 5–10 years later. If this statement is correct, the trends noted from the first to the intermediate time period should follow the same direction as the trends noted between the intermediate and later time period. For many of the cited diseases, however, the R.C.P. data do not confirm this expectation. In coronary heart-disease, for example, the downward trend at ages 35–64 from 1953–57 to 1958–61 is reversed to a slight upward trend from 1958–61 to 1962–65.

(3) The report's claims rest on the statement that during the cited time periods, cigarette smoking declined among British doctors but not in the general population. In my paper I pointed out the inaccuracy of this statement, and noted that from 1961 to 1965 the percentage of cigarette smokers decreased at about the same rate in men of both the medical and general populations. This same observation (of a decline in cigarette smokers after 1960) was made by Doll in his fig. 3 and text of a previous report [2]: "... the per caput consumption of cigarettes ... in men ... began to fall [after 1960]".

You question the source of my data about cigarette smoking. The data for the British doctors came from the R.C.P. report.[1] The data for the U.K. general population came from the same source [3] used by Doll.[2] To convert the original citations into the reported data, I used certain computations that were not published. The details of these computations for the years 1956, 1961, and 1965 are as follows:

Computations of 1956 cigarette smokers only figure of 56%.—Table 7 of the 1957 T.R.C. report [3] gives the % of men for 1956 ages 35–69 smoking packeted cigarettes only as 52·3%, hand-rolled only as 5·7%, hand-rolled and packeted cigarettes as 3·1%, making a total of 61·1%. The % of men ages 60+ smoking packeted cigarettes only is given as 33·3%, hand-rolled only as 6·7%, hand-rolled and packeted cigarettes as 1·7%, making a total of 41·7%. The U.K. adult male 1956 population was 7,473,000 for ages 35–59 and 3,020,000 for ages 60+. To compute % of cigarette smokers only for ages 35+ take 61·1% of 7,473,000 and add 41·7% of 3,020,000 and divide by total population 10,493,000 × 100 = 56%.

Computations of 1961 cigarette smokers only figure of 57%.—Table 12 of the 1969 T.R.C. report [4] gives the number of cigarette smokers only for men for 1961 ages 35+ as 7,120,000 and the total number of smokers for men ages 35+ as 9,220,000. Therefore, percentage of cigarette only smokers as a proportion of all smokers ages 35+ = 7,120,000/9,220,000 or 77%. Table 11a of the 1969 T.R.C. report gives the % of male non-smokers (including ex-smokers) ages 35–59 as 25% (base 1992) and for ages 60+ as 29% (base 789). Therefore, % non-smokers ages 35+ = 25 × 1992 + 29 × 789/2781 = 26%. Percentage of smokers ages 35+ is accordingly 74% (100 − 26). % of cigarette smokers only is 77% of 74%, or 57%.



Secular trends in death-rates and percentage cigarette smokers for British doctors ages 35 to 84 from 1951 to 1966 (standardised for age).

Death-rates taken from table 1 and percentage cigarette smokers from table 4 of Doll and Pike.[5] The dashed lines (semi-bar graphs) show average death-rate values for the periods 1953–57, 1957–61, and 1961–65 as given in table 2 of Doll and Pike.[5]

Computations of 1965 cigarette smokers only figure of 46%.—Table 12 of the 1969 T.R.C. report gives the number of cigarette smokers only for men for 1965 ages 35+ as 5,891,000 and the total number of men smokers ages 35+ as 8,877,000. Therefore, the % of cigarette only smokers as a proportion of all smokers ages 35+ = 5,891,000/8,877,000 or 66%. Table 11a of the T.R.C. report gives the % non-smokers (including ex-smokers) ages 35–59 as 29% (base 1618) and for ages 60+ as 31% (base 720). Therefore, % non-smokers ages 35+ = 29 × 1618 + 31 × 720/2338 = 30%. Percentage of smokers ages 35+ is accordingly 70% (100 − 30). % of cigarette smokers only is 66% of 70%, or 46%.

The results pertain only to the percentage of cigarette smokers, and data were not available for the years before 1956. For the crucial time period between 1961 and 1965 (not the earlier period, as asserted in your editorial), cigarette smoking declined in the general population, although the overall death-rate remained essentially the same. You did not comment on this crucial phenomenon, despite the doubt it raises for the claim that death-rate is reduced by stopping smoking.

Your statement that the "overall consumption of tobacco in the country as a whole has changed very little" is curious. The data to support this statement are attributed to a paper by Doll and Pike [6] and indicate that the average number of cigarettes smoked per day by all adult males in the U.K. was 11·0 for 1951, 11·5 for 1957, and 11·4 for 1966. However, you omit some important intermediate time periods. By computations from the same source [3] used by Doll and Pike, I have found that the comparable figures were 12·5 for 1961 and 11·4 for 1965, thus confirming that a decline in cigarette smoking occurred from 1961 to 1965. Since Doll had previously [2] acknowledged the reduction in the general population's cigarette smoking after 1960, you have placed Doll in the position of contradicting himself.

Your editorial attributed to the paper by Doll and Pike [5] figures of the average numbers of cigarettes smoked per day by doctors (ages 35–61) as 10·8, 8·3, and 5·5 for the years 1951, 1957, and 1966, respectively. But Doll and Pike's paper does not contain such data.

(4) A final point that can be noted in the recent Doll and Pike report [5] is the relationship between death-rate and a reduction in cigarette smoking among British doctors. From tables 1, 2, and 4 of that report, I constructed the accompanying figure. The years 1951–52 and 1952–53 are omitted because of Doll and Pike's suggestion [5] that the mortality-rates in those years are "obviously biased" by the way the cohort of British doctors was selected. The graph shows no correspondence between the death-rates among British doctors from 1953 to 1965, and their simultaneous downward trend in cigarette smoking.

These data from the Doll and Pike report provide perhaps the most vigorous refutation yet offered for the conclusion in your editorial and in the R.C.P. report that "changes in mortality among British doctors provide strong evidence that stopping smoking increases the expectation of life".

Department of Nutrition,
Harvard University School of Public Health,
Boston, Massachusetts, U.S.A. CARL C. SELTZER.

SMOKING AND HEALTH

SIR,—Are we to judge from their silence that Dr. Seltzer's critics have conceded his case (Jan. 29, p. 243, and March 11, p. 586)? Is cigarette-smoking non-lethal?

If the undoubted positive associations between cigarette smoking and death-rates from various diseases are not causal in origin, an alternative explanation is needed. According to Fisher,[1] such associations might arise from constitutional factors. That is to say, one or more of the genes that predispose to certain forms of smoking might be the same as, or linked with, genes that predispose to fatal disorders such as lung cancer. In principle, we can discriminate between causal and constitutional hypotheses by examining deaths in series of twins discordant for smoking habits. The straightforward causal hypothesis predicts that deaths will occur earlier, on the average, in the smoking members of both monozygotic and dizygotic twin pairs. The constitutional hypothesis predicts that "early deaths" will occur with equal frequency, on the average, among the smoking and the non-smoking members of monozygotic twin pairs: where dizygotic twins are concerned, smokers should suffer an excess frequency of "early deaths" over non-smokers.

This simple test of the two hypotheses is, of course, hindered by the rarity of monozygotic twins discordant for smoking habits: only some 20–25% have been found to be strikingly discordant.[1,2]

Despite this obstacle, Friberg et al.[3] have obtained some intriguing results. They studied deaths among 246 male and 326 female monozygotic twin pairs, and in 706 male and 781 female dizygotic twin pairs appreciably discordant ("non-smoker" versus "smoker"; "less exposed" versus "more exposed"), and born in Sweden between 1901 and 1925. Among the dizygotic male twins, deaths were recorded over a standard period as follows: 13 of the "non-exposed and less-exposed" as compared with 34 of the "smoker and more exposed". Among dizygotic female pairs, deaths were recorded in 18 of the "non-exposed and less-exposed" and 20 of the "smoker and more exposed". Results for discordant monozygotic twins were very interesting: 14 deaths were recorded among the "non-exposed and less-exposed" men, but only 9 among the "smokers and more exposed"; among the women, 4 of the "non-exposed and less-exposed" and 6 of the "smoker and more exposed" died. Overall, the "more exposed" (sexes combined) enjoyed a slight but not significant advantage (18/15) over the "non-exposed and less-exposed". On a formal statistical test, the difference in mortality ratios ("non-exposed and less-exposed"/"smoker and more exposed") between the sets of monozygotic and dizygotic male twins corroborates the constitutional hypothesis and rejects (at the 1–2% level) the causal hypothesis (x^2 with Yates' correction = 5·78; $0{\cdot}01 < P < 0{\cdot}02$). However, this result needs to be treated with caution because the degree of discordance for smoking habits between the monozygotic and dizygotic series, although similar, was probably not identical. This reservation apart, the independent findings of Friberg et al.[3] support Dr. Seltzer.

Perhaps the issue could be put beyond reasonable doubt by supplementing the study of Friberg and his colleagues [3] with a world-wide survey under the ægis, say, of the World Health Organisation? And why should not the cigarette manufacturers foot the bill?

General Infirmary,
Leeds LS1 3EX. P. R. J. BURCH.

SMOKING AND HEALTH

SIR,—Professor Burch (June 10, p. 1283) would not have felt that critics of Dr. Seltzer's comments (Jan. 29, p. 243) on evidence concerning changes in mortality-rates of doctors and other men in England and Wales have been silent if he had given more weight to the leading article which you published in the same number as Dr. Seltzer's article (p. 238). Dr. Seltzer's letter (March 11, p. 586) was based on death-rates at all ages and was thus irrelevant to an argument based on changes in death-rates at ages at which stopping smoking could be expected to affect mortality, and thus required no answer. The observations of Friberg et al., which Professor Burch finds so impressive, are very interesting. Since these are based on a very small number of deaths and are in conflict with such a vast array of contrary evidence, it would be unwise to conclude that this evidence alone is valid and all the rest is invalid. If Professor Burch is unaware of other evidence about the constitutional hypothesis, he will find simple statements about it in the Royal College of Physicians' report [1] and more detailed reviews in the Surgeon-General's publications (The Health Consequences of Smoking)—in particular the recent 1971 and 1972 editions.[2,3] I agree with Professor Burch's suggestion that there should be more extensive surveys of mortality in twins with contrasting smoking habits. The difficulty is that these would have to be very large studies, because identical twins tend to have such similar smoking habits that pairs with widely contrasting smoking habits form a very small proportion of the total.

Department of Medicine,
Royal Postgraduate Medical School,
Hammersmith Hospital,
London W.12.

C. M. FLETCHER,
Secretary,
Royal College of Physicians'
Committee on Smoking
and Health.

SMOKING AND HEALTH

SIR,—In your issue of April 29 (p. 960) you published a letter from Dr. Theodore Sterling, of the Department of Applied Mathematics and Computer Science, Washington University, in which he quoted extensively from my articles. According to Sterling the excerpts selected lent support to Seltzer's conclusion (p. 243) that a proper analysis would not show any appreciable difference between the trends in mortality of doctors—many of whom have stopped smoking—and men of the same ages in England and Wales whose smoking habits have remained relatively unchanged. I cannot agree with this contention.

In a letter to *The Lancet* on Feb. 8 (p. 322) I pointed out that the trend of mortality with time after smoking is stopped varies with the nature of the disease, and that in the doctors we had studied the mortality from illnesses related to smoking fell by 38% after 10 or more years. This, Sterling asserts, is contradicted by another statement that after smoking is stopped the incidence of lung cancer remains practically the same as it was at the time of stopping.[1] The reason for the apparent contradiction would not be obvious to anyone who read only these selected statements. It should, however, have been obvious to a mathematician who read them in the context in which they were written. The first statement referred to mortality-rates standardised for age; that is, it compared mortality among men of the same ages. The second referred to the change in the incidence of disease with the passage of time; that is, it compared incidence among men of different ages. Since lung cancer and other diseases related to smoking increase in incidence with age, the two statements are perfectly compatible, and the assertion that Seltzer's conclusion (v.s.) "had been quietly conceded by others, foremost of whom is Doll," is false.

Sterling then quoted me as having reported a decline in cigarette consumption among men in the United Kingdom[2]; which, he said, again supported Seltzer and contradicted your editorial (p. 238). In fact what your editorial said was that the consumption of cigarettes had declined more in doctors than in other men. Nothing I have written contradicts that. No-one disputes the fact that the amount of tobacco smoked by men in Britain has declined since 1960 largely as a result of the introduction of filter-tipped cigarettes. The figures have been published by the Tobacco Research Council and are there for everyone to see,[3] and it is interesting to observe that the mortality from lung cancer in Britain has declined in men under 55 years of age while it has continued to increase at all ages in women, among whom tobacco consumption has continued to increase.

Finally, Sterling refers to the fact that some 30% of the doctors to whom Bradford Hill and I wrote failed to reply, and uses it to cast doubt on the validity of the comparison between the trend in the mortality of those doctors who did reply and the trend in the general population.

The failure to obtain a reply from a substantial proportion of the doctors to whom we originally wrote makes it dangerous to generalise from the respondents to doctors as a whole, as we have repeatedly pointed out.[4] We showed that the doctors who did reply were somewhat healthier than average, so that the mortality-rates among them were at first abnormally low.[4] This bias, however, had largely worn off after 2 years, so that we needed to exclude the first two years' observations from our comparison of trends. From then on the relevant fact is that we were able to keep 99·9% of the doctors under observation for the succeeding 12 years. Doubtless better material could be collected, but I am not convinced that the shortcomings of ours are so great that "not much can be learned" from it.

13 Norham Gardens,
Oxford.

RICHARD DOLL.